Before the Federal Communications Commission
Washington, D.C. 20554

In the matter of Modification of Parts 2and 15 of the Commission's Rules for unlicensed devices and equipment approval.	ET Docket No. 03-201

Comments of Nortel Networks

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- Antenna Technologies

Nortel Networks agrees with the Commission's goal of clarifying the rules for the 2.4 GHz band to address the usage of advanced antenna technologies. This new technology should be encouraged. It is suggested that the definition be clarified to be the 10 dB horizontal angle of the beam and that two, or more, beams must always be used simultaneously. The 10 dB beamwidth measurement is suggested to ensure that devices operating under the new provisions actually do operate with beams and are not simply "omni-directional" antennas with a 3 dB peak. The power limits for the multi-beam devices should be similar to the present rules for point-to-point operation in the 2.4 GHz band.

- Replacement Antennas

Nortel Networks is concerned about the long-term practicality of using a non-standard connector. The practical problem is two-fold. There is a considerable cost penalty in using a non-standard connector and, based on Nortel Networks' experience, if the product is successful and sold in large volumes, the connectors become de facto "standards". Nortel Networks recommends that the restriction on the use of non-standard connectors for antennas be removed for devices operating under parts 15.247 and 15.407 and marketed for commercial use.

- Marketing of Separate Power Amplifiers

Nortel Networks disagrees with the proposal to allow the general marketing of separate power amplifiers. There is the danger that such amplifiers together with adapter cables will become ubiquitous accessories for consumer systems and thereby increasing the potential for interference in the bands. Nortel Networks suggests that the marketing of power amplifiers be restricted to commercial use and by professional installers.

- Harmonization between UNII and 15.247

Nortel Networks agrees that the harmonization by using the measure of the average emission power for both 15.247 and UNII devices would benefit the industry. This change will not have a detrimental effect on existing systems. Nortel Networks recommends that it is appropriate to choose spectrum occupancy characteristics that are commonly used by many RLAN systems that already are in use in these bands.

- Modular Radios

Nortel Networks agrees that appropriate rules and practices are necessary for the certification of modular radio devices. However, Nortel Networks has concern on several of the proposed detailed practices including the use of non-standard antenna connectors, the labeling of modules, and the requirement for a 150 mV digital voltage interface.

- Spectrum Sharing

In the area of dynamic sharing of spectrum, Nortel Networks encourages the Commission to work with the industry to develop "spectrum etiquettes" or similar mechanisms. Since the creation of the U-PCS and UNII rules there has been significant practical progress in the area of dynamic spectrum sharing (such as the IEEE 802.11 standard). These systems are now in widespread deployment and illustrate the practicality of cooperative spectrum sharing within a common standardized etiquette. Nortel Networks recommends that the Commission work together with the industry to develop sharing procedures for existing and new shared or "unlicensed" spectrum based on six basic general principles, similar to those used by the RLAN systems. This is a sharing problem where the success must be judged by the larger number of systems operating in harmony and not by the maximization of throughput by one device or one system.

Nortel Networks is ready to work with the Federal Communications Comission (FCC) and the industry to develop the means, etiquette based or otherwise, to enhance the long-term availability and usability of unlicensed spectrum for communications.

Introduction

Nortel Networks is pleased to have this opportunity to provide these comments and commends the Commission for initiating this proceeding.

Nortel Networks is an industry leader and innovator transforming how the world communicates and exchanges information. The company delivers cost-effective network solutions and services to wireline and wireless telecommunications service providers and enterprises, including Fortune 500 corporations, small businesses, health care, education and government institutions. Working closely with its customers and partners, Nortel Networks is enabling businesses and consumers to benefit from data, voice and multimedia communications that are secure, flexible, easy-to-use, and accessible anywhere and anytime.

Detailed Comments

In its summary of this proceeding, the FCC indicates that it is addressing seven issues. Nortel Networks' comments address each of these issues as outlined below and, for the convenience of the reader, follow the relevant excerpts from the Commission's order.

1. Advanced Antenna Technologies

> *(10) After taking these requests under consideration, we tentatively conclude that spread spectrum systems using sectorized and/or phased array systems could provide important benefits for providing communications to a local area. We also believe that those benefits would outweigh the concerns for interference, i.e., spectrum overcrowding, if the devices comply with appropriate operating conditions.* ***Therefore, we believe that we should revise the rules to clearly facilitate broader deployment of advanced antenna designs with spread spectrum systems and to provide a stable environment in which to foster the continued development and installation of these spectrum efficient technologies."***

Nortel Networks agrees with the Commission's goal of clarifying the rules for the 2.4 GHz band to address the usage of advanced antenna technologies. This new technology should be encouraged.

However, the unlicensed bands are currently very widely used for many applications, especially Radio Local Area Networks (RLAN). These systems are now becoming a pervasive part of the national communications system and as such warrant protection against incompatible devices that may overpower or monopolize the use of the band. The existing devices operate in the band based on sharing principles long established by the Commission using rules for modulations, bandwidths and emissions. New devices within the band should not disturb the existing operations by, for example, the use of higher powers or omni-directional broadcast transmissions.

Nortel Networks recommends that a guiding principle for the introduction of new antenna technologies in this band should be operation within established limits for what could be achieved by multiple individual devices sharing a common antenna structure with multiple radiating elements[1]. However, the new rules must be carefully crafted to ensure that they cannot be interpreted to simply boost the radiated power of a device. Because the spreading-gain requirements are no longer required in the 2.4 GHz band to facilitate sharing, there is a need for some additional rules to protect against inter-device interference. For example, an extension of the etiquette concepts in the U-PCS and UNII rules and discussed further under "spectrum sharing" below, may be appropriate for devices operating under the advanced antenna rules.

The general methods discussed in the NPRM for the usage of advanced antenna systems in the existing unlicensed bands seem generally reasonable. However, detailed comments on specific questions follow.

> *(11) In order to adopt regulations for sectorized and phased array antenna systems used with spread spectrum systems, we must first provide a clear definition of the types of systems that will be accepted.* ***We seek comment regarding the characteristics that a system would need to exhibit in order to be classified as a sectorized or phased array antenna system.*** *As an initial matter, we propose to clarify that sectorized or phased array antenna systems must be capable of forming at least two discrete beams. Second, we propose to limit the total simultaneous beamwidth radiating from the antenna structure to 120º, regardless of the number of beams formed. The 120º of bandwidth need not be continuous and may be divided among various independent beams pointing in different directions around the antenna structure. In this implementation, a sector system or phased array would be permitted to transmit simultaneously in 2 beams of 60º, 10 beams of 12º, or any other combination not exceeding a total of 120º beamwidth. Such a regulation would prevent abuse of our rules by banning phased array systems which, in an extreme case, may be able to form beams of 1º width simultaneously along 360 radials around an antenna structure. An antenna system of such design would appear identical to an omni-directional antenna.*

[1] The existing rules, for example, allow separate devices to be installed in a cluster, with each device having a separate antenna. Such a cluster may aggregate the emission limits. The use of a common, multi-beam antenna structure provides both radio performance and cost advantages. Such a multi-beam device should be permitted to achieve similar performance as an equivalent cluster of individual devices.

Commenting parties should provide detailed suggestions regarding any additional modes of operation that should be considered acceptable as a definition for sectorized or phased array installations.

Nortel Networks agrees that a careful definition of devices operating under the advanced antenna rules is warranted. The proposed definition to include a 120 degree total beam-width with at least two beams is reasonable. Nortel Networks recommends that this further be clarified as the 10 dB horizontal angle of the beam and that the two, or more, beams must always be used simultaneously. We recommend the definition include the 10 dB beamwidth to ensure that devices operating under the new provisions actually do operate with beams and are not simply "omni-directional" antennas with a 3 dB peak[2].

The horizontal angle measurement of the antenna is recommended in order to limit the interference level among nearby systems which are most often horizontally separated. The measurement could be extended to three-dimensions; however, such measurements are in practice very time-consuming[3].

The requirement for simultaneous use of the beams is recommended to preclude a multi-beam device being operated with a single beam as a means to benefit from the additional power allowance. Rules for single beam antennas are provided under existing subsections of 15.247.

> *(12) Sectorized and phased array antenna systems divide the total power from a transmitter among various transmission azimuths and the power may be distributed equally or at varying levels among those azimuths. The radiated emissions are directionalized along each sector or azimuth in order to communicate with an associated receiver. Accordingly, these antenna systems may resemble point-to-point operation at any given moment.* ***Therefore, we propose to allow such systems to operate at the same power levels as point-to-point directional antennas. Specifically, we propose to limit the total power that may be applied to each individual beam to the applicable power level specified in Section 15.247(b), i.e., 0.125 watt or 1 watt, depending upon the type of modulation used. This implies that the total operating power, the aggregate power in all beams, could exceed the output power permitted for a single point-to-point system. We propose, therefore, to limit the aggregate power transmitted simultaneously on all beams to 8 dB above the limit for an individual beam. For instance, the 8 dB limit will enable antenna systems to create up to 6 individual beams or sectors, all operating at the point-to-point limit.*** *Such an implementation is based on our understanding of the capabilities of existing technology. Finally, we propose to require that the transmitter output power be reduced by 1 dB for each 3 dB that the directional antenna gain of the complete system exceeds 6 dBi. This requirement is similar to the present rules for point-to-point operation in the 2.4 GHz band.* ***We seek comment on these proposals.***

[2] A device with a 3 dB antenna peak, for example, is radiating of the order of half its power in directions other than that of the "beam", typically omni-directionally.

[3] This could involve, for example, the measure of 3 dimensional angles as solid angles measured in "steradians" (Ref.: http://en.wikipedia.org/wiki/Steradian).

Further, we seek comment with regard to whether the Commission should specify a maximum E.I.R.P. limit for each individual beam. If so, what should that limit be?

Nortel Networks agrees that each beam should be allowed the same power levels as point-to-point antennas but that the aggregate power should be limited to 8 dB above the single beam limit. We also agree that the EIRP limit for each individual beam should also correspond to that for individual point-to-point antennas. In this case we understand the intent of the "gain of the complete system" to be the antenna beam gain diminished by any associated losses due to the cables, connectors and switching apparatus. We agree that there need be no limit in the rules for the EIRP of individual beams. The limits for the multi-beam devices should be similar to the present rules for point-to-point operation in the 2.4 GHz band. Practically, such devices are limited by the cost and size of the antenna structure.

(13) We note that certain antenna designs also employ adaptive properties such as steerability or beamforming characteristics. The proposed rules will not require that the individual sectors or beams be adaptive. Therefore, the rules will be technology neutral and able to accommodate various antenna system designs. ***With this in mind, we seek comment regarding additional restrictions which may be needed. For example, a phased array antenna system may be able to produce dynamic beams which can overlap one another. In such a case, should there be an additional power reduction required whenever two or more beams overlap?***

Nortel Networks is concerned about the possibility of overlapping beams and the potential for a device to combine or focus several beams for a single user and thereby effecting an 8 dB power increase (as provided in paragraph (12)). However, in a mobile environment it does not seem unreasonable (and, indeed is quite likely) that two beams dynamically tracking two separate users may overlap if the users move close together. In such a case, the device should not be required to reduce its power level to that of a single beam. Nortel Networks therefore recommends that the beams be allowed to overlap only if there is a separate and different information flow in each beam. By "different information" we mean different information being delivered to the user. Different coding, modulation or a delay of the same information would not be considered as two different information streams. Thereby, there is a distinction made between the information flow and the radio bit stream.

(14) The proposed rules will accommodate the phased array antenna systems which the Commission has previously allowed by interpretation of the rules. These systems are now either in advanced stages of development or already deployed in the field. ***We seek comment with regard to the treatment of existing systems in light of any rules adopted as a result of this proceeding. We propose the following compliance schedule: all newly certificated systems must comply upon the effective date of the new rules; certificated systems marketed six months after the effective date must comply with any new rules. We do not propose to require any modifications to existing certificated equipment that is deployed in the field.***

Nortel Networks agrees that this is a reasonable procedure for the introduction of new systems and the new rules. It may also be advantageous to have a moratorium on new antenna systems requiring new interpretations, until the new rule making is completed.

> *(15)* ***We ask if there is any need to modify the compliance testing requirements for systems that employ multiple antennas or radiating elements.*** *Section 15.31(h) of the rules requires that compliance measurements for systems with multiple antennas must be taken with all radiating sources emitting.* ***Should this requirement be applicable to the special case of sector or phased array antennas?*** *Sector antenna systems in particular typically complete a communications link by utilizing specific radiating elements to form a beam. Therefore, testing these systems with all elements radiating simultaneously will not replicate real-world operation.* ***Is the same true for phased array systems? Is it necessary for all radiating elements of sector or phased array antennas to be emitting in order to determine potential out-of-band and spurious emission levels?***

Nortel Networks believes that it is necessary for the antenna system to be fully tested with all of its radiating elements operating as they would during operation of the device or system. This testing may involve tests of individual elements as well as of the ensemble. In order to protect other users of the band as well as systems in other bands, the device with its full antenna must be tested for out-of-band or spurious emissions. Nortel Networks views the existing rules for testing and compliance to be both necessary and sufficient for antennas with multiple radiating elements.

2. Replacement Antenna Restriction for Part 15 Devices.

> *(16) Section 15.203 requires that intentional radiators be designed such that no antenna other than that supplied can be used with the device. The rules state that the device can be designed such that a broken antenna can be replaced by the user;* ***however, the use of a standard antenna jack or electrical connector is prohibited****. These rules are intended to prevent intentional circumvention of the Part 15 emission limits by replacing a device's authorized antenna with an antenna having higher gain characteristics.*

Nortel Networks is concerned about the long-term practicality of using a non-standard connector. The practical problem is two-fold. There is a considerable cost penalty in using a non-standard connector and, based on Nortel Networks' experience, if the product is successful and sold in large volumes, the connectors become de facto "standards". Even if a non-standard connector is used, it is quite common for adapter-connectors to be marketed by third parties, thereby canceling the protection of the non-standard fitting.

In other parts of the world market, the use of non-standard connectors is not mandated. Nortel Networks recommends that the restriction on the use of non-standard connectors for antennas be removed for devices operating under parts 15.247 and 15.407 and marketed for commercial use. Such systems are typically sold through authorized resellers and professionally installed as part of larger communications systems.

(17) We wish to develop more flexible antenna requirements for unlicensed devices. We propose to provide that flexibility by requiring testing only with the highest gain antenna of each type that would be used with the transmitter at the maximum output power of that transmitter. Any antenna of a similar type that does not exceed the antenna gain of tested antennas may be used without retesting. Use of an antenna of a different type than the tested antenna (*i.e.* yagi antenna vs. a horn antenna) or one that exceeds the gain of a tested antenna would require retesting and new approval by either a Telecommunication Certification Body or the Commission. Manufacturers would be expected to supply a list of acceptable antenna types with applications for equipment authorization.

Nortel Networks agrees that permitting the flexible use of antennas would considerably benefit the industry. The use of any antenna meeting stated gain and pattern limits is preferable over the existing requirement for certification with individual antennas. The current rules have proved difficult in that a change by the antenna manufacturer, or deletion of a previously certified model, can result in the need (and consequent expense) to recertify a system. The generic approach also allows the system installer and integrator to choose an antenna that is suitable for the coverage required. This may be less than the maximum allowed when the coverage area is small or overlaps that of an adjacent unit (this is also discussed in the next section Topic 3). Such freedom will considerably improve the economics and efficiency of systems.

3. Equipment Authorization Procedures.

(19) We are proposing a number of rule changes to enable WISPs to customize their transmission systems without the need to obtain a new equipment authorization for every combination of components. Specifically, we will allow professional radio system installers and parties that offer a commercial radio service under the unlicensed rules to substitute technically equivalent components in systems that have been granted equipment authorization. We believe such parties have the technical competence to ensure that the systems they deploy continue to comply with the FCC rules. ***We invite comment as to whether specific criteria are necessary to qualify as a professional radio system installer or commercial service provider, and if so, what those criteria should be. We also request views as to whether any other parties should be afforded similar flexibility. We will require the professional installer or commercial service provider to place a label on the transmission system that lists the FCC Identification Number of the system that was granted equipment authorization, identifies any components that were substituted, and designates a point of contact for the party that installed the system.***

Nortel Networks agrees that it would significantly benefit the industry if the installers of radio equipment have the flexibility to choose the detailed configuration of the installation. Such installers have the technical competence to assure the end system complies with the Commission's rules. Such installers may come from the ranks engineering specialists who are qualified to engineer radio systems, the manufacturers' engineering design staff, and those who certify equipment for authorization under part 15

rules. It may also be possible for other parties to configure installations, if they are following specific procedures laid out by certifying parties or choosing from among preset configurations that have been chosen by qualified engineers.

Nortel Networks agrees that it is important that the installer fully labels the installation with identifiers and the address of a contact party. Nortel Networks also suggests that the label should include a warning that the system configuration should not be changed with out consultation with and the agreement of the initial and subsequent certifying parties.

> *(20) We also propose to allow marketing of separate radio frequency power amplifiers on a limited basis. We will restrict such marketing to amplifiers that are only capable of operation under the spread spectrum rules in Section 15.247 and under the U-NII rules for the 5750 – 5850 MHz band. These are the rules under which WISPs currently offer most service and under which most unlicensed wireless broadband devices operate. Further, we propose to require that such amplifiers obtain an equipment authorization (certification) and demonstrate that they cannot operate with an output power of more than 1 Watt, the maximum permitted under the rules. We believe that this rule change would be of benefit not only for WISPs, but also for consumers and businesses generally. For example, consumers and businesses would have the ability to obtain a separate amplifier if they find the device they have purchased has insufficient operating range to meet their needs.* ***We invite comment as to whether we should instead provide only a more narrow relaxation to allow separate marketing of power amplifiers that are designed in a way such that they can only be used with a specific system that is covered by an equipment authorization, such as through use of a unique connector or via an electronic handshake with a host device.*** *We also recognize that frequency hopping systems that employ fewer than 75 hops are limited to an output power of 125 mW and invite comment as to whether the unique connector requirement may be necessary to ensure that 1 Watt amplifiers are not used with devices that are limited to 125 mW. We invite comment on these proposals and solicit views on other ways the equipment authorization rules might be modified to provide added flexibility without creating undue risk of interference to radio services or unlicensed devices.*

Nortel Networks disagrees with the proposal to allow the general marketing of separate power amplifiers. The proposed restrictions appear insufficient to protect against the inadvertent or malicious use of power amplifiers. The use of special connectors, for example, seems insufficient because adapter connectors will become readily available. Such amplifiers would then become ubiquitous accessories for consumer systems increasing the potential for interference in the bands. Nortel Networks suggests that the installation of power amplifiers be restricted to professional installers (as discussed under paragraph (19)) who are required to certify the compliance of the installation and its continued compliance. Such installations may then be done, for example, through the use of "kits" of compatible items including power amplifier, driver, antenna and cables that have been developed by qualified engineers to assure compliance with the rules.

4. Harmonization of Rules between UNII and Section 15.247

(23) Accordingly, we propose to harmonize the measurement procedures for digital modulation devices authorized under Section 15.247 with the digital U-NII devices authorized under Section 15.407. Specifically, we propose to allow entities performing compliance testing for Section 15.247 devices to use an average, rather than overall peak, emission as provided by Section 15.407, paragraphs (a)(4) and (a)(5) when measuring transmit power. We propose this change for devices using digital modulation that operate in the 915 MHz, 2.4 GHz and 5.7 GHz bands. ***We seek comment on whether a change in measurement procedure for such devices would have any detrimental impact on the installed base of products.***

(24) Aside from the differences in measurement procedures, Section 15.247 and U-NII devices also differ in spectrum occupancy characteristics. For example, a Section 15.247 device operating in the 5.7 GHz band is required to limit peak power spectral density to 8 dBm in any 3 kHz band, which equates to 33 dBm in any 1 MHz band. Unwanted emissions from such a device are not required to be attenuated to the general emission limits of Section 15.209. Conversely, the same device, if authorized pursuant to the U-NII rules, would be required to limit its power spectral density to 17 dBm in any 1 MHz band and to limit unwanted emissions to the levels specified in Section 15.209. Realizing that a device may occupy the same spectrum band differently depending upon the rule section under which it is authorized, would a common procedure for measuring output power be appropriate and provide an accurate assessment of device performance? ***Should we amend the spectrum occupancy rules for Section 15.247 and U-NII devices to apply the same limits to both types of devices, and if so, which limits should be applied?***

Nortel Networks agrees that the harmonization of the procedures and measurement rules between section 15.247 and UNII would benefit the industry.

Using the measure of the average emission power for both 15.247 and UNII devices will reduce the cost of testing and also harmonize with the rules already developed for similar systems in Europe. This change will not have a detrimental effect on existing systems.

Nortel Networks recommends that it is appropriate to choose spectrum occupancy characteristics that are commonly used by many RLAN systems that already are in use in these bands. These systems provide up to 30 dBm in a 20 MHz bandwidth (or about 17 dBm/MHz) as the RF power into the antenna. Using this limit would maintain the compatibility among existing systems and would also harmonize with similar regulations in Europe. This limit also would be in-line with the original aim of the UNII rules to provide broadband wireless services. This occupancy limit is to be preferred over the 33 dBm/MHz limit (from part 15.247) that allows the power to be concentrated in narrow-band channels (i.e. 30 dBm in 500 KHz bandwidth) and would thereby cause excessive interference to other broadband users of the band.

5. Frequency Hopping

(29) Accordingly, we propose to modify the frequency hopping spacing

requirement to permit certain systems in the 2.4 GHz band to utilize hopping channels separated by either 25 KHz or two-thirds of the 20 dB bandwidth, whichever is greater. We recognize that although a single device's channels will not overlap in time, the use of multiple devices simultaneously in a given area may cause the spectral occupancy and power density to increase, leading to an increased risk of interference. ***Therefore, we seek comment on the interference potential of new waveforms with more gradual roll-off and potentially higher spectral power densities at the channel band edges.***

Nortel Networks agrees with the aim of allowing more efficient modulation techniques to be used by devices using frequency hopping radios. However, as these devices share the band with "non-hopping" devices there is a potential for interference. Many non-hopping devices use a listen-before-transmit protocol for sharing, and such devices would be caused to defer their use of a channel by hopping devices that hop onto their channels. Increasing the allowed bandwidth of the hoppers increases the likelihood of such interference.

Nortel Networks agrees that the hopping devices should be allowed to utilize either a hop channel separation of 25 kHz or two-thirds of the 20 dB channel bandwidth subject to the PSD limit discussed in paragraph (30).

(30) We note that the current rules place output power limitations on frequency hopping systems based upon the number of hopping channels used. Specifically, systems in the 2.4 GHz band that use at least 75 hopping channels are allowed 1 watt output power. However, systems that use fewer than 75 hopping channels are limited to 125 mW output power. In general, many systems that employ fewer than 75 hopping channels use hopping channels that are wider than those that use 75 or more channels. In allowing these wider hopping channels, the Commission recognized that a reduction in the maximum permitted output power was needed in order to minimize any potential interference risk. We tentatively conclude that an output power limit of no more than 125 mW is also appropriate for those systems that use more narrowly spaced channels than currently permitted. ***In line with previous Commission findings, we believe that this restriction will ensure that systems using the narrow-spaced, slightly wider hopping channels will not overcrowd the 2.4 GHz band with relatively high-power emissions. We seek comment on this proposal.***

Nortel Networks agrees that devices using narrowly spaced hopping channels should be limited to a 125 mW EIRP.

6. Modular Radios

(34) We believe that it is appropriate to update the Commission's practices for approving modular transmitters to accommodate both existing modular devices and emerging partitioned modular architectures (consisting of the firmware, radio front end, local oscillator and tuning capacitors, and antenna), so long as they meet certain guidelines. Accordingly, we are proposing to codify the eight criteria for approving modular transmitters contained in the 2000 Public Notice.

Nortel Networks agrees that appropriate practices are necessary for the certification of modular radio devices. Such designs incorporating both software and hardware modules are already common in the industry for operation in both unlicensed and licensed bands.

The eight criteria referenced in the NPRM seem generally appropriate. However, Nortel Networks has the following comments on several of the details.

Criteria 4, stipulating the use of non-standard antenna connectors is of concern to Nortel Networks. As already discussed under paragraph (16), the requirement for these special connectors has considerable negative impact on costs and their protection is quickly lost with the availability of adapters. The advantage of modules for customers is also completely lost if each manufacturer has a different connector. Nortel Networks suggests that as the modules of a system are typically configured and contained within an engineered configuration and enclosure that there need be no restriction on the use of connector types.

Criteria 6, stipulating the labeling of modules both inside and outside the unit is of some practical concern to Nortel Networks. There may be a very large number of possible configurations, internal modules may change late in the manufacturing cycle depending on the details of the customer requirements, and may involve both hardware and software. Software may also be updated after the system has been deployed. A printed label on the unit may also become obscured (blocked) when the unit is enclosed in other packaging. Nortel Networks recommends that a more practical approach may be for the unit to be labeled externally to the effect that it has been certified, its ID number and that it may contain modules from a designated list. The information on the modules contained in the individual unit may be determined through an electronic query through the device maintenance channel. Thus, the unit configuration can be determined from the modules themselves without the need to maintain correspondence between printed labels and the unit configuration.

The proposal that "the interface between the sections of the modular system must be digital with a minimum signaling amplitude of 150 mV peak-to-peak" concerns Nortel Networks. This seems to be unnecessarily restrictive of technology and implementation. It would apparently limit the technology of interconnection that might occur between chips or within chips being used as modules. Optical interconnections between modules, or other new technology would also be precluded. Optical interconnections will likely become widespread as the bandwidth of radio modules increases. The requirement for a 150 mV digital voltage interface is also incompatible with modules that may communicate via software through an intermediate network. Nortel Networks recommends that the restriction on digital interfaces be replaced by a more general requirement that the interfaces between modules that need be visible for certification be made available though suitable means to the testing lab.

7. Spectrum Sharing

> *(44)* ***We invite comment on whether the Commission should consider any other methods to ensure efficient spectrum usage by unlicensed devices.*** *For example, we note that the industry developed and the Commission adopted a "spectrum etiquette", or sharing conditions, for the operation of Unlicensed PCS devices operating under Part 15 of its rules. The etiquette establishes a set of steps a*

device must follow before it may access the spectrum. The etiquette requires that devices monitor the spectrum in which they intend to operate. The device may begin transmission only if no signal above a specified threshold is detected.

(45) ***We invite comment on whether a spectrum sharing etiquette should be considered for devices that operate on an unlicensed basis, in addition to Unlicensed PCS devices. If so, should the Commission or the industry develop the criteria establishing access conditions?*** *What characteristics need to be considered (e.g. spectrum monitoring requirements, bandwidth limits, variable output power levels)? Could an etiquette be implemented in such a way as to ensure continued flexibility for technological development, which has been the cornerstone of unlicensed operation?* ***If a spectrum sharing etiquette is feasible, we seek comment regarding the bands to which the etiquette should apply. Finally, given the number of unlicensed devices currently in operation without a sharing etiquette, how effective will such an etiquette imposed on new entrants be in improving spectrum sharing?***

Nortel Networks encourages the Commission to work with the industry to develop "spectrum etiquettes" for operation within unlicensed spectrum bands. Nortel was an active participant in the development of the U-PCS and UNII etiquette rules. These etiquettes were time-consuming to develop and codify in the rules and have been a challenge for the industry in general to comprehend and to test in practice.

Such complexity in the wording is a reflection of the technical complexity of the general problem of sharing spectrum between technically diverse systems. It is difficult (perhaps even impossible) to codify general rules for devices with different bandwidths, powers, modulations, burst profiles and channel centers[4]. It is also very difficult to formulate general rules for a transmitter that will adequately protect a receiver (which is often "invisible")[5]. Much of the complexity of the wording of the U-PCS and UNII rules is a result of generalization in an attempt to cover a very wide range of technical possibilities.

Since the time of the development of the U-PCS and UNII rules, there has been significant practical progress in the area of dynamic spectrum sharing with the development of the RLAN standards, such as those of the IEEE 802.11 committee. These systems are now in widespread deployment and illustrate the successful, dynamic cooperative spectrum sharing possible within a common standardized etiquette.

The key to the success of the RLAN sharing etiquette is that the systems have a similar service basis and utilize a common set of modulations, power levels, bandwidths and

[4] While such a generalized system may be possible in theory, in practice the cost of a wideband, multi-channel scanning receiver accommodating multiple channels and modulation formats is prohibitive for low-cost commercial systems and the real-time needed to scan thoroughly before each transmission would considerably increase the system delay and reduce capacity.

[5] This is the classic "hidden-node" problem that is fundamental to spectrum sharing etiquettes. Although a transmitter may scan the spectrum it intends to use, listening for any activity, it may not detect a weak signal being received (from a distant station) by a nearby neighboring receiver. The new transmissions thus may block the reception of the weak signal by the "hidden node" neighbor. This problem is made technically very difficult if the channel centers, bandwidths, power levels and modulation are different between the two systems.

channel centers. A signaling protocol is also used to enable hidden nodes to be detected and thereby protect nearby receivers from adjacent transmitters[6]. These systems have practically demonstrated their ability to share the spectrum capacity among systems with overlapping coverage areas. Such devices do not generate interference to their neighbors, but rather, defer their transmissions in time until the radio medium is clear.

Such harmony among devices is impossible with out a set of clearly defines rules (an "etiquette"). The RLAN etiquette is made practical by a number of fundamental factors including:

(1) a common channel plan,
(2) common channel bandwidths,
(3) common power levels,
(4) prescribed deference behavior and thresholds,
(5) a protocol to accommodate hidden nodes, and
(6) the use of packet transmission bursts.

The RLAN systems are based on packet bursts in which a device does not transmit unless it has a packet to send and the channel has been sensed to be free from other packets. All transmitters are quiescent if they have no information to send. It is this packet nature of the transmissions that creates the openings that enable others to share the spectrum capacity. Continuous transmissions by one device, that would block all the others, are not permitted with the standard systems (cf. Rec. ITU-R M.1450).

Nortel Networks recommends that the FCC work together with the industry to develop an etiquette for this and new shared or "unlicensed" spectrum based on the six basic principles listed above that are similar to those used by the RLAN systems. This is a sharing problem where the success must be judged by the larger number of systems operating in harmony and not by the maximization of utilization by one device or one system.

Because of the global nature of the communications industry, Nortel Networks also works with other administrations world-wide. Many of these administrations already provide unlicensed spectrum that contain practical sharing etiquettes. These are most often codified by reference to an internationally agreed standard. These standards define the channel plans, power levels, modulation formats, signaling and sharing protocols that are the basis for a sharing etiquette.

Nortel Networks suggests a similar approach may be suitable here. As an example, two (or more) categories of unlicensed spectrum may be defined.

One category would not require the use of any etiquette and sharing would be facilitated through the control of transmitter emissions similar to the present regime. Such bands, typically the existing unlicensed bands, could be used for new (experimental) services, technology under development and existing devices.

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[6] The hidden node problem, for example, is resolved in the RLAN protocol by requiring both the transmitting and receiving nodes to exchange short packets at the beginning of a burst sequence. This causes the hidden receiver to reveal itself to its neighbors who may then defer their transmissions until the current activity is completed. Such a solution is possible because the neighboring devices share a common channel plan, modulation formats and protocol.

Other categories, typically for application in unlicensed spectrum being newly assigned, would have a sharing etiquette mandated though reference to an international standard. These latter would support services that use more mature technology and have established service quality expectations and so are prepared for the additional effort required to adhere to a standardized etiquette. Several categories may be required to support different types of services that are based on different operating concepts.

Typically it would be expected that new technologies would develop and mature in the non-etiquette category and move to one of the etiquette categories when the technology and the service have matured. As the introduction of an etiquette within a system often involves the application of a protocol above the physical layer, such may be added to a product (with additional software) once its service is established and its underlying physical (radio) system is mature.

Conclusion

Nortel Networks is ready to work with the FCC and the industry to develop the means, etiquette based or otherwise, to enhance the long-term availability and usability of unlicensed spectrum for communications.